Vighnesh Nagpal

Curriculum Vitae · University of California, Berkeley

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Education & Employment

Berkeley Radio Astronomy Laboratory — *Berkeley, CA, USA*
Junior Specialist — *Jan 2024 -*

University of California, Berkeley — *Berkeley, CA, USA*
Bachelor of Arts, Physics and Astrophysics — *Aug 2020 - Dec 2023*
- GPA: 3.77/4

Publications

First-Author

1. **V. Nagpal**, M. Goldberg, K. Batygin. 2024. Breaking Giant Chains: Early-Stage Instabilities in Long-Period Giant Planet Systems. *Submitted to The Astrophysical Journal*. Manuscript available here.
2. **V. Nagpal**, S. Blunt, B.P. Bowler, T.D. Dupuy, E.L. Nielsen, J.J. Wang. 2023. The Impact of Bayesian Hyperpriors on the Population-Level Eccentricity Distribution of Imaged Planets. *AJ*, 165, 32.
3. **V. Nagpal** and J.S. Dillon. 2022. The Detectability of FRBs with HERA. *HERA Memo Series #112*. Available at: http://reionization.org

Contributing Author

1. M. Morgan, B.P. Bowler, and 4 colleagues inc. **V. Nagpal**. 2024. Signs of Similar Stellar Obliquity Distributions for Hot and Warm Jupiters Orbiting Cool Stars. *AJ, 167, 2.* arxiv:2310.18445 .
2. B.P. Bowler, Q.H. Tran, and 11 colleagues inc. **V. Nagpal**. 2023. Rotation Periods, Inclinations, and Obliquities of Cool Stars Hosting Directly Imaged Substellar Companions: Spin-Orbit Misalignments are Common. *AJ*, 165, 164.
3. The HERA Collaboration: Z. Abdurashidova, T. Adams, J.E. Aguirre, and 90 colleagues inc. **V. Nagpal**. 2023. Improved Constraints on the 21 cm EoR Power Spectrum and the X-Ray Heating of the IGM with HERA Phase I Observations. *ApJ*, 945, 124.
4. S. Blunt, J.J. Wang, and 11 colleagues inc. **V. Nagpal**. 2020. orbitize!: A Comprehensive Orbit-fitting Software Package for the High-contrast Imaging Community. *AJ*, 159, 89.

In Preparation

1. **V. Nagpal**, J.S. Dillon, A.R. Parsons, and colleagues. 2024. Limits on FRB Occurrence Rates from 110–180 MHz with HERA Phase I Observations.
2. S. Blunt, **V. Nagpal**, and colleagues. 2024. The Mysterious Case of HD104304: A Heavy G-Dwarf or a Hidden Companion?
3. S. Ghosh, D. Gadotti, F. Fragkoudi, **V. Nagpal**, and P. Di Matteo. 2024. Closing the gap: secular evolution of bar-induced dark-gaps in presence of thick disks.

Awards, Fellowships, & Grants

2024	**Chambliss Astronomy Achievement Student Award**, 243rd Meeting of the American Astronomical Society. See the announcement here.	
2023	**Berkeley Physics Undergraduate Research Program Scholar**, UC Berkeley	*$ 1,500*
2022	**Chambliss Award: Honorable Mention**, American Astronomical Society	
2022	**Summer Undergraduate Research Fellowship**, California Institute of Technology	*$ 6,700*
2022	**Berkeley Physics Undergraduate Research Program Scholar**, UC Berkeley	*$ 1,500*
2022	**Dean's List**, UC Berkeley	

Presentations

Contributed Talks

V. Nagpal. "Breaking Giant Chains: Early-Stage Instabilities in Long-Period Giant Planet Systems." Lunch talk, Department of Astronomy, UC Berkeley. November 2023.

V. Nagpal. "The Impact of Bayesian Hyperpriors on the Population-Level Eccentricity Distribution of Imaged Planets." Emerging Researchers in Exoplanet Science VII, The Pennsylvania State University, PA, USA. August 2022.

V. Nagpal and J.S. Dillon. "The Detectability of Fast Radio Bursts with HERA." HERA Collaboration Meeting. January 2022.

V. Nagpal. "New results for the eccentricity distribution of imaged giant planets." Lunch talk, Department of Astronomy, UC Berkeley. October 2021.

V. Nagpal. "Precise Dynamical Masses for the HD-104304 G-M Binary." Lunch talk, Department of Astronomy, UC Berkeley. April 2021.

V. Nagpal. "Orbitize: a Python package for fitting orbits to directly imaged planets." Boston Area Exoplanet Science Meeting VII, Harvard–Smithsonian Center for Astrophysics. April 2019.

Posters

V. Nagpal, J.S. Dillon, A.R. Parsons. Methods for Detecting FRBs with the Hydrogen Epoch of Reionization Array." 243rd American Astronomical Society Meeting, New Orleans, LA, January 2024. Available here.

V. Nagpal, S. Blunt, B.P. Bowler, T.D. Dupuy, E.L. Nielsen, J.J. Wang. 'The Impact of Bayesian Hyperpriors on the Population-Level Eccentricity Distribution of Imaged Planets." 240th American Astronomical Society Meeting, Pasadena, CA, June 2022.

V. Nagpal, J.S. Dillon and A.R. Parsons. Estimating the Detectability of Fast Radio Bursts with HERA. BPURS Poster Session, UC Berkeley, April 2022.

V. Nagpal et al. "Using long baseline radial velocities and direct imaging to make 13-sigma dynamical mass measurements for the components of the HD 104304 stellar binary." 237th American Astronomical Society Meeting, Virtual Meeting, January 2021.

Teaching Experience & Service

2023	**Astronomy C10**, Undergraduate Student Instructor	
2023	**Berkeley Astronomy Small Council**, Undergraduate Student Representative	
2021 & 2022	**Code/Astro**, Teaching Assistant	
2020	**Wonders of the Universe**, Instructor	*Online*

Research Experience

Transiting Exoplanet Population-Level Inference Below the Detection Limit *UC Berkeley*

Advisor: Professor. Uros Seljak *2024 - Ongoing*

- Developing new techniques for hierarchical Bayesian analysis of Kepler data for studying planetary populations lying right below traditional detection limits for the catalog.

Searching for Fast Radio Bursts with the Hydrogen Epoch of Reionization Array (HERA) *UC Berkeley*

Advisors: Dr. Joshua Dillon, Professor Aaron Parsons *Spring 2021 - Ongoing*

- Carried out simulations to forecast the detectability of low-frequency Fast Radio Bursts (FRBs) in data from the Hydrogen Epoch of Reionization Array (HERA) telescope in South Africa.
- Developed an analysis pipeline to use for searching for radio transients in HERA data. Successfully demonstrated this new method's ability to detect injected FRBs in realistic HERA data. Currently leading the search for FRBs and other radio transients in archival HERA data.

Impact of Bayesian Hyperpriors on the Eccentricity Distribution of Imaged Planets *Dept. of Astronomy, Caltech*

Advisors: Dr. Sarah Blunt, Professor Brendan Bowler *June 2021 - Nov 2022*

- Devised improved methods for using Hierarchical Bayesian Modeling (HBM) to infer population level eccentricity distributions for exoplanets. Using these techniques, I re-analyzed the observational sample of imaged substellar companions from Bowler et al. (2020) and found that the eccentricities of imaged giant planets at wide separations resemble those of close-in exoplanets studied through radial velocity monitoring.
- Showed that imaged brown dwarfs and giant planets have different eccentricity distributions regardless of hyperprior choice—strengthening the evidence for distinct formational channels.
- Wrote and released a new software package, `ePop!`, for performing population-level analyses using HBM. This software is available at: `https://github.com/vighnesh-nagpal/ePop`

Mapping the Dynamical Evolution of Resonant Chains of Giant Planets *Department of GPS, Caltech*

Advisors: Professor Konstantin Batygin, Max Goldberg *June 2022 - October 2023*

- Created and ran a large-scale suite of N-body dynamical simulations to investigate the long-term evolution of initially resonant configurations of planetary systems with multiple giant planets.
- Comparing the properties of our synthetic systems with the California Legacy Survey sample of giant planets, I found that two-planet initial conditions broadly struggle to match the observed giant planet population.
- On the other hand, initial conditions with three or more planets can potentially evolve into a population consistent with the observed California Legacy Survey sample of giant planets. However, within our simulations, Hot Jupiters are not produced frequently enough to explain a sizable fraction of the observed Hot Jupiter occurrence rate.

Modelling the evolution of Galactic Bars with N-body Simulations *MPIA Heidelberg*

Advisors: Dr. Soumavo Ghosh, Dr. Gregory Green *June 2023 - August 2023*

- Analyzed N-body simulations of galaxy evolution to study the galactic bar-driven excitation of vertical breathing modes in disk stars over cosmic time.
- Measured the bar pattern speed for simulated galaxies, with the aim of understanding how pattern speed evolution is affected by the early-stage properties of galactic thick disks.

Development of `orbitize!` and precise orbital characterization of the HD-104304 stellar binary. *UC Berkeley, Caltech*

Advisors: Dr. Sarah Blunt, Professor Lea Hirsch, Professor Jason Wang *2019 - 2021*

- I added parallel processing functionality to the 'Orbits for the Impatient' `(OFTI)` orbit fitting algorithm in `orbitize!`, a widely used Python package for fitting the orbits of directly imaged planetary and stellar systems.
- Working with Roberto Tejada (Princeton), I helped develop `orbitize`'s ability to jointly fit radial velocity and astrometric data for planetary systems. I then added a module to handle orbit fitting using Markov Chain Monte Carlo (MCMC) methods on datasets containing observations taken with multiple instruments.
- Using `orbitize!` and image processing methods for coronagraphic images, I conducted an orbital analysis for HD 104304, a stellar binary containing a GIV star and M dwarf. Through this work, we calculated precise dynamical masses for each star and placed constraints on the presence of additional bodies in the system. Paper in prep.

Coursework

- **Fall 2020:** *Introduction to Mathematical Physics*; *Introduction to Mechanics and Special Relativity*; *Roots of Western Civilization*; *Introduction to Japanese*.
- **Spring 2021:** *Introduction to Astrophysics Introductory Electromagnetism, Waves, and Optics*; *Introduction to Analysis*; *Introduction to Experimental Physics I*; *Ideas of Education*
- **Fall 2021:** *Introduction to Thermodynamics and Quantum Mechanics*; *Analytical Mechanics*; *Introduction to Experimental Physics II*; *Intermediate Japanese*
- **Spring 2022:** *Quantum Mechanics*; *Introduction to Statistical and Thermal Physics*; *Planetary Astrophysics*; *Intermediate Japanese*; *Reading, Composition and Research*
- **Fall 2022:** *Quantum Mechanics II*; *Radiative Processes in Astronomy*(graduate-level); *Electromagnetism and Optics*; *Astronomy Data Science Laboratory*; *Advanced Japanese*.
- **Spring 2023:** *Relativistic Astrophysics and Cosmology*; *Instrumentation Laboratory*; *Buddhism in Contemporary Society*; *Advanced Japanese*
- **Fall 2023:** *Advanced Instrumentation Laboratory*; *The Biosphere*; *Understanding Korean Popular Culture*; *Encounter and Conquest in Indigenous America*; *Professional Preparation: Supervised Teaching in Math and the Physical Science*

Skills

Proficient in Python, Java, cluster computing, parallel computing. Extensive experience with astronomical software development and the usage of Bayesian and machine learning methods for astronomical data analysis.